ON THE SYNONYMY BETWEEN *BARBUS BRAZZAI* PELLEGRIN, 1901 AND *B. ALVAREZI* ROMAN, 1971 FROM CENTRAL AFRICA WITH A REDESCRIPTION AND DATA ON ITS GEOGRAPHIC VARIATION (OSTARIOPHYSI: CYPRINIDAE)

by

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ABSTRACT. - The validity of two nominal African cyprinid species, *Barbus brazzai* and *B. alvarezi* was examined using morphometrics. Ninety five specimens, including the type specimens of both nominal species, were studied; data were analysed using univariate and multivariate statistics. Results obtained confirmed the synonymy of both species, with *Barbus brazzai* as the senior synonym. Its redescription is given.

RÉSUMÉ. - Sur la synonymie entre *Barbus brazzai* Pellegrin, 1901 et *B. alvarezi* Roman, 1971 d'Afrique Centrale. Redescription et données sur ses variations géographiques (Ostariophysi: Cyprinidae).

La validité de deux espèces nominales de Cyprinidae, *Barbus brazzai* et *B. alvarezi* a été examinée à l'aide des techniques morphométriques. Quatre-vingt quinze spécimens ont été étudiés, y compris les types des deux espèces nominales; les données obtenues ont été soumises à des analyses statistiques univariées et multivariées. La synonymie des deux espèces a été démontrée, avec *Barbus brazzai* comme nom prioritaire. Une redescription de cette espèce est donnée.

Key-words. - Cyprinidae, *Barbus brazzai*, *Barbus alvarezi*, Morphometrics, Synonymy.

Barbus brazzai was described by Pellegrin (1901) on a single specimen from the Sangha river (Middle-Zaïre Basin). It belongs to the small-sized *Barbus* species. In its original, short description, the author stated that this species is diagnosed amongst others by the dorsal fin which lacks spines, and by the absence of barbels. Mahnert and Géry (1982) in their paper on the *Barbus* species of the Ivindo river (Ogowe Basin, Gabon), gave a complete account of this species, also mentioning the presence of cephalic pores on the head in the holotype of *Barbus brazzai*. In the cyprinid section of the Check-List of the Freshwater Fishes of Africa, Lévêque and Daget (1984) reported this species from the Ogowe, Sangha and Ivindo rivers.

In 1971, *Barbus alvarezi* was described by Roman from the Ntem river basin in Equatorial Guinea. In his key diagnosis and description, the author mentioned the lack of barbels, as well as the absence of spines in the dorsal fin, and the presence of numerous vertical stripes on the operculum. He, however, did not compare his new species with *B. brazzai*. In the Check-List of the Freshwater Fishes of Africa, Lévêque and Daget (1984) reported the species as only known from the type locality.

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In 1995, De Vos published on the synonymy of *Barbus tshopoensis* De Vos, 1991 with *B. brazzai*. This synonymy implied an important range extension for the latter, as *B. tshopoensis* was described from the Central Zaïre basin near Kisangani in Zaïre, and from near Bambari in the Central African Republic.

From the existing descriptions, we are unable to indicate differences between *Barbus brazzai* and *B. alvarezi*. As part of an ongoing study on the biodiversity of the fresh- and brackish water fishes of the Ntem river basin in Cameroon, this paper studies the taxonomic status of these two nominal species.

MATERIALS AND METHODS

Ninety five specimens, housed in the Musée Royal de l'Afrique Centrale (MRAC), Tervuren (Belgium), the Muséum National d'Histoire Naturelle (MNHN), Paris (France) and the Museo de Colegio la Salle Bonanova, Barcelona (Spain) have been examined. Details on their origin are given in the list of specimens examined (*cf. infra*).

For each specimen, 18 measurements and 9 meristics were taken. These follow Tshibwabwa and Teugels (1995), except for the body height. The latter was taken between the dorsal and ventral fin origins. Radiographs were made on 87 specimens for vertebral counts. The latter also followed Tshibwabwa and Teugels (1995).

For univariate analyses, an approach based on comparison of populations from neighbouring hydrographic systems was used in order to avoid the effect of geographical distance, as suggested by Mayr (1942), and followed by Thys van den Audenaerde (1970) and Teugels (1986) for the study of complex groups such as *Tilapia* and *Clarias* respectively, and recently by Lévêque and Guégan (1990) in their study of West African large *Barbus*.

Six geographically distinct populations were studied: (1) Ntem (Cameroon-Equatorial Guinea), with one specimen from the Nyong river (Cameroon) included; (2) Ogowe (Gabon); (3) Bambara (Middle-Zaïre, Central African Republic); (4) Ikela (Middle-Zaïre, Zaïre); (5) Buta (Middle-Zaïre, Zaïre); (6) Kisangani (Middle-Zaïre, Zaïre).

Statistical analyses were made including descriptive statistics and principal component analysis (PCA) using the STATISTICA package (versions 3.1 for analysis and 5.1 for graphs). Data have been log-transformed ($\log_e$) in order to homogenise variance and minimise effects of non-normality of data. Moreover, the use of the variance-covariance matrix in PCA, as performed in this study, supposed that the data are log-transformed, which allows for a direct interpretation of character loadings and a direct comparison between populations (Bookstein *et al.*, 1985).

RESULTS

The metrics and the meristics for the populations studied are given in table I. Slight differences are observed for the means of several characters. Mean comparison tests such as Mann-Whitney U-test, however, could not be used because for some populations an insufficient number of individuals was present for comparison. The comparison of unbalanced groups would have been influenced by undesirable allometric effects. This allometric effect however was excluded by using the PCA. Results of the PCA carried out on 17 log transformed metric variables, do not allow recognition of distinct populations.

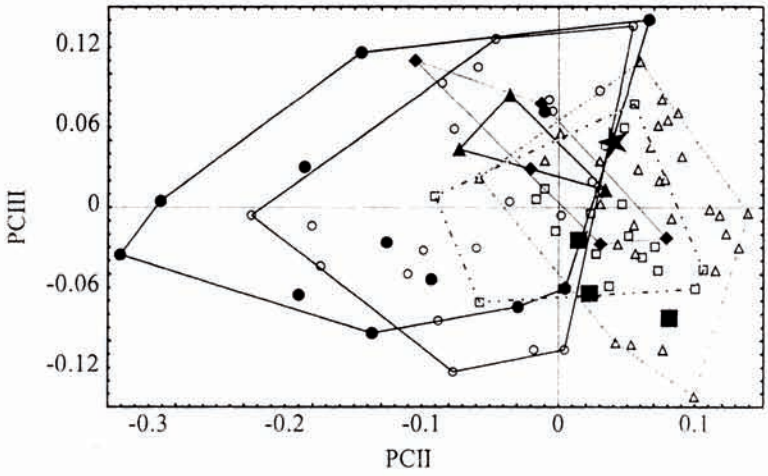

Fig. 1. - Plot of the second principal component (PCII) against the third principal component (PCIII) derived from a principal component analysis of 17 log transformed metric variables. (★) Holotype of *Barbus brazzai*; (■) holotype and paratypes of *Barbus alvarezi*; (❑) population from the Ntem Basin; (Δ) population from the Ogowe Basin; (▲) population from Central African Republic (Middle-Zaïre basin); (◆) population from Ikela (Middle-Zaïre Basin); (O) population from Buta (Middle-Zaïre basin); (●) population from Kisangani (Middle-Zaïre Basin).

A scatterplot of the second principal component (PCII) against the third principal component (PCIII) showed an overlap between these populations (Fig. 1). Geographically most distant populations (Kisangani, Ogowe and Ntem) are least overlapping.

The first principal component of the morphometric data as suggested by Humphries *et al.* (1981) and Bookstein *et al.* (1985), is interpreted as a size component and the further components represent shape, independant of size. Size accounts for 97.3% of the observed variance and the PCII accounts for 0.6%. Contributions over the second and third axis are given in table II. In this analysis, the holotype and paratype of *Barbus alvarezi* and the holotype of *B. brazzai* are closely set and all fall within the polygones of the Ntem and, or the Ogowe specimens.

For the meristics, and especially for the number of lateral line scales and gill-rakers on the cerato- and hypobranchial, some variation exists (see Table I), but mainly in the populations situated at the extremity of the range distribution. The holotype of *Barbus brazzai* showed 29 lateral line scales (versus 28 for the holotype and the two paratypes of *B. alvarezi*), and 6 gill-rakers (versus 5 for the holotype and one of the paratype of *B. alvarezi*, and 6 for the second paratype).

The Ntem population showed either 0, 2 (only the anterior pair) or 4 short barbels, and tip of the dorsal is very dark. The Ogowe population showed either 0 or 2 short barbels (the posterior pair). The tip of dorsal is somewhat darkish. The Zaïre population showed an important variation in the number of the barbels, from either 0, 2, 3 or 4 short or long barbels, and the tip of dorsal is somewhat darkish. The type-series of *Barbus alvarezi* as well as the holotype of *B. brazzai* lack barbels and show a dorsal which is darker distally, although this color is not well marked in the type of *B. brazzai*.

Table I. - Main meristic and metric variables for all populations examined of *Barbus brazzai*. (ABD) represents the number of abdominal vertebrae, and (CAUD) that of caudal vertebrae. *Continued.*

Characters	Holotype	Ntem					Ogowe					RCA				
		n	Mean	Min	Max	SD	n	Mean	Min	Max	SD	n	Mean	Min	Max	SD
Standard length SL (mm)	82.1	23	85.8	63.6	101.9	9.9	30	61.1	54.2	68.5	4.0	3	66.1	61.5	71.9	5.3
in % Head length																
Head width	48.8	23	54.4	50.9	61.8	2.4	30	51.8	48.9	55.9	1.8	3	52.5	52.4	52.6	0.1
Snout length	26.4	23	27.1	25.8	29.9	1.1	30	26.8	24.7	29.6	1.0	3	26.0	24.4	26.8	1.4
Eye diameter	31.0	23	29.2	25.9	33.3	1.9	30	32.3	28.4	35.8	1.6	3	33.7	32.5	34.4	1.0
Interorbital distance	26.9	23	22.9	18.6	28.8	2.4	30	22.0	19.2	23.8	1.2	3	21.8	20.6	23.0	1.2
In % SL																
Head length	29.5	23	29.0	27.2	30.2	0.7	30	29.1	27.0	31.0	0.9	3	29.0	28.5	30.0	0.9
Caudal peduncle length	22.3	23	20.8	19.3	21.8	0.7	30	21.4	18.9	23.9	1.2	3	20.0	19.6	20.4	0.4
Caudal peduncle height	18.4	23	20.0	18.2	21.4	0.9	30	17.5	16.0	19.0	0.7	3	17.7	17.1	19.0	1.1
Body height	33.0	23	34.7	30.4	38.9	2.4	30	29.4	26.6	31.5	1.1	3	30.5	29.8	30.9	0.6
Pre-dorsal distance	49.7	23	50.1	48.5	52.1	0.9	30	49.6	46.6	53.0	1.4	3	50.5	49.2	51.7	1.3
Pre-anal distance	73.7	23	76.1	73.2	81.2	1.8	30	74.8	72.0	77.1	1.2	3	75.2	73.3	76.9	1.8
Pre-pelvic distance	49.8	23	50.0	48.9	51.3	0.7	30	50.1	48.4	51.8	0.8	3	49.4	47.9	50.2	1.3
Pre-pectoral distance	27.3	23	28.0	26.8	29.1	0.6	30	28.2	26.9	29.8	0.7	3	28.1	27.4	28.9	0.7
Anal base length	7.1	23	7.2	6.6	8.2	0.4	30	7.1	5.9	8.1	0.5	3	7.2	7.0	7.4	0.2
Dorsal base length	15.8	23	16.0	14.2	17.1	0.7	30	15.5	14.2	16.2	0.5	3	17.2	16.8	17.6	0.4
Pectoral length	23.0	23	24.1	21.9	26.5	1.3	30	23.7	22.0	26.0	1.1	3	22.3	21.2	23.2	1.0
Pelvic length	25.3	23	26.8	24.8	29.3	1.1	30	26.0	24.1	27.7	1.0	3	23.8	22.7	24.5	0.9
	Holotype	**n**	**Median**	**Min**	**Max**	**SD**	**n**	**Median**	**Min**	**Max**	**SD**	**n**	**Median**	**Min**	**Max**	**SD**
Gill-rakers on hypo-ceratobranchial	6	23	6	4	7	0.9	30	6	4	7	0.7	3	5	3	7	2
Longitudinal scales	29	23	28	28	29	0.4	30	28	27	29	0.5	3	27	27	27	0
Vertebrae (Abd-Caud)		16	14-15				9	14-15								
		1	14-14				8	14-14				2	14-14			
							1	15-14								
							1	13-15				2	13-15			

Table I. - *Continued.*

Characters	Ikela					Buta					Kissangani				
	n	Mean	Min	Max	SD	n	Mean	Min	Max	SD	n	Mean	Min	Max	SD
Standard length SL (mm)	5	48.5	44.0	59.7	6.5	21	49.1	23.7	65.5	12.8	12	65.3	52.4	75.5	8.0
In % Head length															
Head width	5	48.4	45.2	50.8	2.2	21	53.0	47.2	60.0	3.6	12	53.3	45.7	57.4	3.3
Snout length	5	28.5	26.8	29.8	1.1	21	28.4	25.9	32.0	1.8	12	27.4	25.2	31.4	1.7
Eye diameter	5	32.6	30.4	34.1	1.4	21	32.7	29.6	36.2	1.9	12	33.0	28.3	36.4	2.4
Interorbital distance	5	20.1	19.4	20.7	0.6	21	21.1	19.1	23.7	1.2	12	22.7	20.1	25.4	1.4
In % SL															
Head length	5	30.6	30.1	31.4	0.5	21	30.3	27.7	33.2	1.5	12	31.5	29.0	33.9	1.5
Caudal peduncle length	5	20.5	19.8	21.4	0.6	21	20.3	19.4	22.1	0.9	12	19.7	18.3	21.6	1.0
Caudal peduncle height	5	15.7	15.0	16.2	0.5	21	16.8	13.1	18.4	1.2	12	19.4	17.6	20.7	0.9
Body height	5	30.7	27.9	34.3	2.6	21	29.1	24.1	33.3	2.3	12	31.8	29.2	34.2	1.5
Pre-dorsal distance	5	49.6	48.8	50.6	0.8	21	48.9	45.8	51.0	1.3	12	50.3	45.2	52.4	2.0
Pre-anal distance	5	74.1	73.2	75.4	0.9	21	74.5	72.0	77.7	1.4	12	76.7	73.8	80.0	1.7
Pre-pelvic distance	5	48.8	46.2	49.9	1.5	21	49.6	48.2	53.1	1.2	12	51.4	42.6	55.5	3.3
Pre-pectoral distance	5	28.1	27.2	28.5	0.5	21	30.2	27.2	33.2	1.5	12	30.4	28.6	33.2	1.5
Anal base length	5	7.1	6.7	7.9	0.5	21	7.3	6.4	8.6	0.6	12	7.4	6.4	8.3	0.5
Dorsal base length	5	16.8	16.2	17.6	0.6	21	16.4	13.9	17.7	1.0	12	16.9	16.0	18.3	0.6
Pectoral length	5	22.9	21.8	24.4	1.3	21	22.2	20.7	24.5	1.1	12	23.8	20.8	25.8	1.3
Pelvic length	5	25.2	24.3	26.8	1.2	21	24.7	23.4	27.4	1.0	12	25.6	24.3	27.1	1.0
	n	**Median**	**Min**	**Max**	**SD**	**n**	**Median**	**Min**	**Max**	**SD**	**n**	**Median**	**Min**	**Max**	**SD**
Gill-rakers on hypo-ceratobranchial	5	5	4	5	0.55	21	4	4	5	0.44	12	5	3	5	0.7
Longitudinal scales	5	27	26	28	0.71	21	27	26	28	0.54	12	26	25	27	0.7
Vertebrae (Abd-Caud)											1	14-15			
	4	14-14									23	14-14			
	1	13-15				9	13-15				9	13-15			

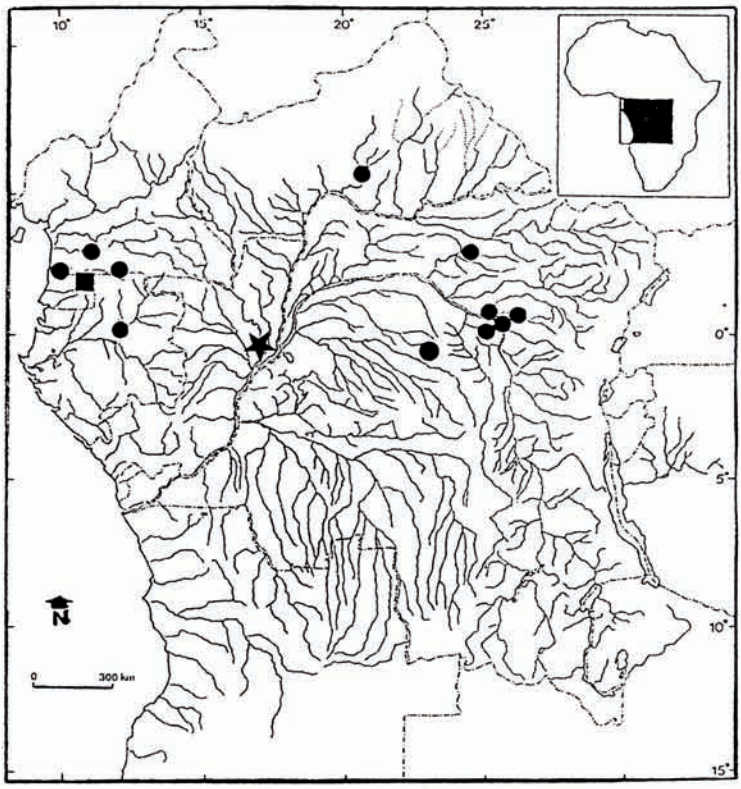

Fig. 2. - Geographical distribution of *Barbus brazzai*. (★) Type locality; (■) holotype and paratypes of *B. alvarezi*.

Table II. - Factor score coefficients of the principal component analysis using 17 log transformed metric variables.

	PC II	PC III
Log caudal peduncle length	.0424	.0170
Log caudal peduncle height	.0068	.0029
Log body height	.0037	.0219
Log head length	-.0203	-.0003
Log head width	-.3669	-.0139
Log snout length	-.4173	-.0056
Log eye diameter	-.0232	.0150
Log interorbital distance	-.0077	-.0022
Log pre-dorsal distance	.0084	.0056
Log pre-anal distance	.0069	.0090
Log pre-pelvic distance	.0025	.0103
Log pre-pectoral distance	-.0233	.0033
Log dorsal base length	-.0105	.0036
Log anal base length	.0015	-.0380
Log pectoral length	.0247	-.0254
Log pelvic length	.0306	-.0214

DISCUSSION

The above results present no compelling morphometric evidence to warrant recognition of *Barbus alvarezi* as distinct from *B. brazzai*. The metric variables, are nearly identical for the two species. The meristics are also quite similar, with minor differences. The variations observed for the number of lateral line scales and gill-rakers (see Table I), however deserve some comments. Although a marked cline was not found for these characters, we noted that the differences only occur between the geographically most distant populations. Morphological variation has already been demonstrated among African large *Barbus* (see Thys van den Audenaerde, 1967; Banister, 1973; Lévêque and Guégan, 1990) as well as in small African *Barbus* (see Banister, 1980, 1987). In a rather complex group as that of Cyprinids, it is not evident to demonstrate the variation that is due to local environment and that which should be considered as specific (Lévêque and Guégan, 1990). However, the evidence that these populations belong to the same species is also demonstrated in figure 1. It can be observed that the neighbouring populations are more closer to each other than are geographically distant ones. This could be viewed, as indirect evidence of gene flow among neighbouring populations of the same species, which evidently cannot take place in populations occupying the extreme ranges of the distribution area of the species. Complementary genetic studies migth be useful in evaluating this variability.

With regards to the variation in barbel number as described above, the usefulness of barbels in barbine classification has already been proved doubtful and undue reliance should not be given to this character, which may be subject to a considerable variability at the species level (Banister 1980, 1987).

In conclusion, no discriminant characters have been observed among all populations examined. The differences we observed seem to be attributable to natural variability as often observed within African *Barbus*. We therefore consider *Barbus alvarezi* as a junior synonym of *B. brazzai*. A redescription of this species is given below.

BARBUS BRAZZAI PELLEGRIN, 1901

Synonyms and citations. - *Barbus alvarezi* Roman, 1971 (new synonym); *Barbus tshopoensis* De Vos, 1991 (see De Vos, 1995); *Barbus brazzae*: Boulenger, 1902, 1905, and 1911; Matthes, 1964; Fowler, 1976.

Holotype. - MNHN n° 1886-404, 82.1 mm standard length (SL); "Mobaka"; coll. De Brazza.

Other specimens examined. - Nyong River (Cameroon): MRAC 73-18-P-1805, Ebogo, coll. Thys van den Audenaerde D., 29-31 Mar.1973. Ntem River (Equatorial Guinea): Museo la Salle (Barcelona), Rio Bolo affluent del Kie, coll. Roman B., 9 Aug.1967; Holotype of *Barbus alvarezi*. Museo la Salle (Barcelona), Rio Bolo affluent del Kie, coll. Roman B., 9 Aug.1967; Paratype of *Barbus alvarezi*. MRAC 164722, Rio Muni, Rio Bolo affluent del Kie, coll. Roman B., 9 Aug.1967; Paratype of *Barbus alvarezi*. Ntem River (Cameroon): MRAC 73-18-P-1110-117, Aboulou, Kom riv., coll. Thys van den Audenaerde D., 6 Apr.1973. MRAC 73-18-P-1118-125, Aboulou, Kom riv., coll. Thys van den Audenaerde D., 7 Apr.1973. MRAC 93-108-P-0229, Aboulou, Kom riv., coll. Kamdem Toham A., 30 Jun.1993. MRAC 93-108-P-027-0228, Aboulou, Kom riv., coll. Kamdem Toham A., 29 Jun.1993. MRAC 95-019-P-0498, Bongola riv., coll. Kamdem

Toham A., 18 Sep.94. Ogowe River (Gabon): MRAC 88-28-P-326-450, Booué, Coll. Van Neer W., 21-22 Jun.1988. Zaïre River (Zaïre, C.A.R.): MRAC 59638-665, Buta, coll. Hutsebaut J., 1939. MRAC 64012-014, Buta, coll. Hutsebaut J., 1939. MRAC 131234-238, Ikela, Makombe riv., coll. Matthes H., 13 Sep.1959. MRAC 61301, Buta, coll. Hutsebaut J., 1939. MRAC 62982-995, Buta, coll. Hutsebaut J., 1939. MRAC 66649-653, Buta, coll. Hutsebaut J., 1939. MRAC 61258-268, Buta, coll. Hutsebaut J., 1939. MRAC 88-25-P-1587, Kisangani, Tshopo riv., downstream hydroelectric dam, coll. De Vos L., 15 Apr.1988; Holotype of *Barbus tshopoensis*. MRAC 87-42-P-1069-089, Kisangani, Tshopo riv., 500 m downstream hydroelectric dam, coll. De Vos L. *et al*, 14 May 87; Paratypes of *Barbus tshopoensis*. MRAC 1058-068, Kisangani, Tshopo riv., 500 m upstream hydroelectric dam, coll. De Vos L. *et al*, 13 May 87; Paratypes of *Barbus tshopoensis*. MRAC 88-25-P-1591-592, Kisangani, Tshopo riv., downstream hydroelectric dam, coll. De Vos L., 14 May 88; Paratypes of *Barbus tshopoensis*. MRAC 87-42-P-1098, Kisangani, Tshopo riv., downstream hydroelectric dam, coll. De Vos L. *et al*, 4 Jun.87; Paratype of *Barbus tshopoensis*. MRAC 82-13-P-1851-854, 15 km from Bambari, Liwa-ouaka confluence, coll. De Vos L. and Kempeneers J., 22 Jan.1982; Paratypes of *Barbus tshopoensis*. MRAC 87-42-P-1090-097, Kisangani, downstream hydroelectric dam, coll. De Vos L. *et al*, 2 Jun.1987; Paratypes of *Barbus tshopoensis*. MRAC 87-42-P-1104-106, Bafwaboli, Tshopo riv., coll. De Vos L., 29 Jun.1987; Paratypes of *Barbus tshopoensis*.

Diagnosis. - Dorsal without spine and serrations, more or less darker distally; head covered with numerous cephalic pores; barbels present or absent; 25-29 lateral line scales; body sides silvery coloured.

Description. - Metric and meristic characters based on 95 specimens, including the holotype are given in table I.

Snout rounded, with a straigth profile till the back of the neck, which is somewhat elevated till the dorsal-fin origin. The snout, cheek and interorbital distance are covered with numerous sensory pores, which are displayed either in parallel or in bifurcated lines. Eye diameter of moderate size, 25.9-36.4% head length. 3-7 gill-rakers on the first gill-arch.

The barbel number varies depending on the geographical origin of the specimens: the Ntem (Cameroon, Equatorial Guinea) populations display either 0, 2 (the anterior pair) or 4 short barbels; one specimen from the Nyong (Cameroon) shows 4 short barbels; the Ogowe populations displays 0 or 2 short barbels (only the posterior pair); the Middle-Zaïre populations have either 0, 2 (only the posterior pair), 3 (one posterior pair and only one anterior barbel) or 4 barbels (either 2 equal short barbels, or an anterior pair rudimentary or more shorter than the posterior).

Pectoral fin i, 15-16: reaches or almost reaches the pelvic-fin origin. Dorsal fin iii, 8: slightly concave or showing a straight profile in its posterior border. Pelvic fin i, 8-9: reaches or almost reaches the anal. Anal-fin iii, 5. Lateral line complete and almost straigth. 3.5 scales (4.5 observed in 4 specimens of the Middle-Zaïre Basin, around Kisangani) between lateral line and dorsal-fin origin; 25-29 lateral line scales; 2-2.5 scales between lateral line and pelvic-fin origin; 3.5 scales between lateral line and mid-venter; 12 caudal peduncle scales.

28-29 vertebrae, but some slight variations were found in the number of abdominal and caudal vertebrae. In the Lower Guinea Province, 14 abdominal and 15 (or 14) caudal are common, while in the Zaïre Province, 14 (or 13) abdominal and 14 (or 15) are often encountered.

Maximum size observed 137 mm TL.

Coloration. - In the Ntem river Basin, live specimens are silvery coloured on the sides and the belly. The upper part of the head is slightly grey. The dorsal fin is darker distally. This distal black spot is well marked, whereas in the other basin it is hardly noticeable. The rest of the dorsal fin as well as the caudal fin are orange coloured. For these fins, Mahnert and Géry (1982) reported a lemon-orange colour in the Ogowe specimens, while De Vos (1991) reported a pink-orange colour in the Middle-Zaïre specimens (around Kisangani). The others fins are transparent. Scales are either dark or brown at their base.

In alcohol, preserved specimens generally showed a brown or a dark-brown colour.

Distribution. - *B. brazzai* is presently known from the Middle-Zaïre Basin (Zaïre; Congo; Central African Republic), the Ogowe (Gabon), the Ntem and the Nyong basins (Cameroon) (Fig. 2).

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